

### Claims

What is claimed is:

1. A method of producing a laser resonator microchip comprising at least a laser crystal and a nonlinear optical crystal, said method comprising:
  - providing a laser crystal wafer and a nonlinear optical crystal wafer;
  - gluing an inside surface of said laser crystal wafer to an inside surface of said nonlinear optical crystal wafer using a UV curable glue to form a bonded wafer assembly; and
  - dicing said bonded wafer assembly to form at least one laser resonator microchip.
2. The method of claim 1 further comprising interferometrically aligning said laser crystal wafer and said nonlinear optical crystal wafer.
3. The method of claim 1 wherein gluing said inside surfaces comprises:
  - anchoring either said laser crystal wafer or said nonlinear optical crystal wafer to provide an anchored wafer;
  - applying UV curable glue to either said laser crystal wafer or said nonlinear optical crystal wafer;
  - aligning the other of said laser crystal wafer or said nonlinear optical crystal wafer with said anchored wafer; and
  - exposing said glue to UV light.
4. The method of claim 3 further comprising exposing said UV curable glue to light provided by a monochromatic source while aligning said other wafer, and wherein said other wafer is manipulated until fringes formed by said light disappears.
5. The method of claim 1 further comprising applying an anti-reflective dielectric coating to said inside surfaces of said laser crystal wafer and said nonlinear optical crystal wafer prior to gluing said surfaces.
6. The method of claim 1 wherein said laser crystal wafer is made of a laser crystal material selected from the group consisting of Nd:YVO<sub>4</sub>, Nd:YAG, Nd:YALO, and Nd: YLF.

7. The method of claim 1 wherein said nonlinear optical crystal wafer is made of a nonlinear optical crystal material selected from the group consisting of KTP and  $\text{LiNbO}_3$ .
8. The method of claim 1 wherein said laser crystal wafer is made of  $\text{Nd:YVO}_4$  and said nonlinear optical crystal wafer is made of KTP.
9. The method of claim 1 wherein an outside surface of said laser crystal wafer is coated to be reflective at a fundamental laser wavelength and at an output wavelength and transmissive at a pump wavelength, and wherein an outside surface of said nonlinear optical crystal wafer is coated to be reflective at said fundamental laser wavelength and transmissive at said output wavelength.
10. The method of claim 9 wherein said output wavelength is in the green spectral region.
11. The method of claim 1 wherein an outside surface of said laser crystal wafer is coated to be reflective at 1064 nm and at 532 nm and transmissive at 808 nm, and wherein an outside surface of said nonlinear optical crystal wafer is coated to be reflective at 1064 nm and transmissive at 532 nm.
12. The method of claim 11 wherein said inside surfaces of said laser crystal wafer and said nonlinear optical crystal wafer are anti-reflective coated at 1064 nm and 532 nm.
13. The method of claim 1 further comprising placing an outcoupler adjacent an outside surface of said nonlinear optical crystal of said laser resonator microchip.
14. The method of claim 13 further comprising gluing an inside surface of said outcoupler to said outside surface of said nonlinear optical crystal of said laser resonator microchip.

15. A method of making a diode-pumped microlaser, said method comprising:  
providing a laser crystal wafer and a nonlinear optical crystal wafer;  
gluing an inside surface of said laser crystal wafer to an inside surface of said nonlinear optical crystal wafer using a UV curable glue to form a bonded wafer assembly;  
dicing said bonded wafer assembly to form at least one laser resonator microchip; and  
packaging said laser resonator microchip in a diode laser package such that said laser resonator microchip is aligned with a laser diode pump source.

16. The method of claim 15 wherein packaging said laser resonator microchip comprises applying UV curable glue to a mounting structure within said diode laser package, positioning said laser resonator microchip on said optical glue, aligning said laser resonator microchip with said laser diode pump source, and at least partially curing said optical glue when said laser resonator is aligned.

17. A laser resonator microchip comprising:  
a laser crystal having an inside surface and an outside surface;  
a first anti-reflective dielectric coating on said inside surface of said laser crystal, wherein said first anti-reflective dielectric coating is anti-reflective at a fundamental laser wavelength and at an output wavelength;  
a nonlinear optical crystal having an inside surface and an outside surface;  
a second anti-reflective dielectric coating on said inside surface of said laser crystal, wherein said second anti-reflective dielectric coating is anti-reflective at said fundamental laser wavelength and at said output wavelength; and  
a layer of UV cured glue between said first and second anti-reflective dielectric coatings, wherein said nonlinear optical crystal and said laser crystal are glued together and interferometrically aligned.

18. The laser resonator of claim 17 wherein said outside surface of said laser crystal wafer is coated to be reflective at said fundamental laser wavelength and at said output wavelength and to be transmissive at a pump wavelength, and wherein said outside surface of

said nonlinear optical crystal wafer is coated to be reflective at said fundamental laser wavelength and transmissive at said output wavelength.

19. The laser resonator of claim 17 wherein said output wavelength is in the green spectral region.

20. The laser resonator microchip of claim 17 wherein said anti-reflective dielectric coatings are anti-reflective at 1064 nm and 532 nm, wherein said outside surface of said nonlinear optical crystal is coated to be reflective at 1064 nm and transmissive at 532 nm, and wherein said outside surface of said laser crystal is coated to be reflective at 1064 nm and at 532 nm and transmissive at 808 nm.

21. The laser resonator microchip of claim 17 further comprising an outcoupler aligned with said nonlinear optical crystal, said outcoupler having an inside surface and an outside surface.

22. The laser resonator microchip of claim 21 wherein said outside surface of said laser crystal wafer is coated to be reflective at said fundamental laser wavelength and at said output wavelength and to be transmissive at a pump wavelength, wherein said outside surface of said nonlinear optical crystal wafer is coated to be anti-reflective at said fundamental laser wavelength and at said output wavelength, and wherein said inside surface of said outcoupler is anti-reflective coated at said fundamental laser wavelength and at said output wavelength, and wherein said outside surface of said outcoupler is reflective at said fundamental laser wavelength and transmissive at said output wavelength.

23. The laser resonator microchip of claim 21 wherein said outside surface of said laser crystal wafer is coated to be reflective at said fundamental laser wavelength and at said output wavelength and to be transmissive at a pump wavelength, wherein said outside surface of said nonlinear optical crystal wafer is coated to be anti-reflective at said fundamental laser wavelength and at said output wavelength, and wherein said inside surface of said outcoupler is

reflective at said fundamental laser wavelength and transmissive at said output wavelength, and wherein said outside surface of said outcoupler is anti-reflective at said output wavelength.

24. The laser resonator microchip of claim 21 wherein said inside surface of said outcoupler is glued to said outside surface of said nonlinear optical crystal of said laser resonator microchip using a UV curable glue.

25. A diode-pumped microlaser comprising:  
a laser diode package;  
a laser diode pump source mounted on a support structure in said laser diode package;  
a laser resonator microchip mounted on an extended portion of said support structure in said laser diode package, said laser resonator microchip being aligned with said laser diode pump source, said laser resonator microchip comprising:  
a laser crystal; and  
a nonlinear optical crystal glued to said laser crystal.

26. The diode-pumped microlaser of claim 25 wherein said laser resonator microchip is configured to produce laser light having a wavelength in the green spectral region.

27. The diode-pumped microlaser of claim 25 wherein said nonlinear optical crystal is glued to said laser crystal using a UV curable glue.

28. The diode-pumped microlaser of claim 25 wherein said laser crystal wafer is made of Nd:UVO<sub>4</sub> and said nonlinear optical crystal wafer is made of KTP.

29. The diode-pumped microlaser of claim 25 wherein an inside surface of said laser crystal is anti-reflective coated at 1064 nm and 532 nm, wherein an outside surface of said laser crystal is coated to be reflective at 1064 nm and at 532 nm and transmissive at 808 nm, and wherein an inside surface of said nonlinear optical crystal is anti-reflective coated at 1064 nm and 532 nm, and wherein an outside surface of said nonlinear optical crystal is coated to be reflective at 1064 nm and transmissive at 532 nm.

30. The diode-pumped microlaser of claim 25 further comprising an outcoupler adjacent an outside surface of said nonlinear optical crystal of said laser resonator microchip.

31. The diode-pumped microlaser of claim 25 wherein said laser package has a maximum outside diameter of about 9mm.

32. The diode-pumped microlaser of claim 31 wherein said laser diode pump source has an output power of about 1 W, and wherein said microlaser produces an output of about 20 mW of laser light having a wavelength of 532 nm.

33. The diode-pumped microlaser of claim 32 wherein said resonator microchip has a size of about 1mm x 2mm.

34. The diode-pumped microlaser of claim 25 wherein said nonlinear optical crystal is interferometrically aligned with said laser crystal.